Green Roofs Mitigate Storm Water and Clean the Environment

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As North America becomes more developed, increasingly large areas of land are being covered with impervious surfaces such as buildings, roads, and parking lots. When storms occur, runoff, which contains atmospheric contaminants deposited in rainfall, can impose a significant threat to watersheds locally and regionally. However, extensive green roofs, especially in urban environments, can significantly reduce runoff.

Extensive green roofs cover large areas and are thin (100-150 mm deep), mostly planted with low-growing plants like sedums. Plant size and selection depends on the depth of the roof overburden (growing medium) and local climate, but almost always consists of winter-hardy, drought-tolerant, perennial plants. Although some information about extensive green roofs is available, replicated performance specifics, especially as they relate to roof hydrology or the cleansing effects of green roofs, are mostly patented, proprietary, or anecdotal.

The Center for Green Roof Research at Penn State has six small (2x2.66 M) buildings. Three have asphalt roofs and three are fitted with extensive green roofs. Roof slope is 8.33% (1:12), and the buildings are oriented in a north-south direction. The green roofs consist of 76 mm of an expanded, clay-based mineral substrate placed on top of a 20 mm drainage layer (Enkadrain 9615, Colbond, Enka, NC). Thus the total roof profile is 96 mm deep. The green roofs are vegetated mainly with *Sedum spurium* and cover 90-100% of the surface. All buildings have gutters that are enclosed and connected to calibrated runoff barrels (capacity 208 L) fitted with pressure transducers ((Omega PX26 Series, ±0.2 % of 6.89 kPa (1 psi))) to measure runoff. Pressure transducers are connected to a Campbell 23X data logger (Campbell Instruments, Logan, UT). Buildings are insulated with 76 mm of household fiberglass insulation on all sides. Paneling (6.25 mm thick) was placed on all interior surfaces, over the insulation. Buildings are equipped with space heaters (1 kW)) and air conditioners (3 kW), and instrumented to collect data on storm water quantity and quality.

Our preliminary research results show that green roofs reduce storm water runoff by about 50%, while the remaining runoff is slowed down from leaving the roof by up to 6 h. Similarly, green roofs improve storm water quality by increasing pH, lowering turbidity and nitrate-nitrogen.

In cooperation with EPA-ORD (Region 3), the Penn State facilities have been modified to collect data to validate the use of green roofs as an EPA approved BMP for storm water management.